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# PILOT PROGRAM FOR THE APPLICATION

NOAA-OGP's Pilot Program for the Application of Climate Forecasts has evolved in conjunction with advances in the accuracy and utility of climate predictions, and with progress in applications and training made during workshops that the scientific community has supported since 1991.<sup>9</sup> The primary purpose of these initial activities was to develop a forecaster/user dialogue and provide a venue for information exchange among researchers and decision makers in climate-sensitive sectors around the world. As the prediction capability and the interest in climate forecasts on the part of decision makers increased, the need emerged for more formalized programs that would address applications in a systematic, comprehensive manner, and at the same time support the development of the International Research Institute for Climate Prediction (IRI). NOAA-OGP's Pilot Applications Program was intended to help meet these needs.

NOAA-OGP's Pilot Program for the Application of Climate Forecasts encompasses a suite of activities which collectively provide the mechanisms for transforming research results into information designed to assist potential users, and distributes that information to key decision makers in the public and private sectors. The purpose of the Pilot Applications Program is in collaboration with interested individuals, institutions, and countries around the world to advance the following objectives:

- Analysis of the anticipated impacts of projected climate-related changes in the physical environment on natural and human systems;
- Studies on vulnerability to short-term fluctuations in climate, and the influence of changing socioeconomic conditions;
- Development, evaluation, and use of improved assessment techniques and methodologies which provide for the integration of physical climate forecasts into existing decision-making structures;

- Analyses of how the adoption of climate forecasts will alter management decisions in climate sensitive sectors, and how these new patterns of adjustment will, in turn, affect other sectors, the environment, and society as a whole;
- Dissemination of targeted forecast analysis products designed to address specific resource problems or economic sectors; and
- Education and training of a multinational cadre of scientists and decision makers skilled in the use and interpretation of new forecast capabilities and analysis techniques.

The Pilot Program had several initial regional foci (Latin America; Southeast Asia; Southern Africa; and the South Pacific), which were selected based on ENSO's clear physical and socio-economic impact in these areas. In order to address forecast applications in a systematic manner and provide as much consistency as possible, the activities in each region were based on common methodology, beginning with an analysis of the climatic and socioeconomic impacts of ENSO, and culminating in the successful incorporation of climate forecast information into existing decision-making processes. Each region's unique physical, social, and cultural characteristics influence its adaptive capacity and ability to successfully use a climate forecast, and consequently the way in which it experiences the impacts of climate variability. The methodology therefore drew from several approaches tailored to fit the needs and interests of a particular region, but cross-fertilization between regional experiences was expected and encouraged.

The objectives of the Pilot Applications Program are progressing through an integrated set of activities, conducted by a range of stakeholders. The primary methodological elements of the program are the following:

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<sup>9</sup> Early efforts involved a course on Ocean-Atmosphere Interactions in the Tropics (August 1991), and a workshop on Tropical Climate Variability and Applications (August 1992), at the International Center for Theoretical Physics (ICTP) in Trieste, Italy.

- Element 1: Preparatory Studies

Develop 6-12 month projects designed to indicate the potential for acting upon climate forecast information to mitigate climate-related impacts in affected sectors (agriculture, human health, water resource management, disaster preparedness, etc.);

- Element 2: Capacity Building for Applying Climate Forecasts

Share preparatory study results, and develop longer-term (12-18 month) pilot application projects which will begin the systematic production and distribution of experimental climate-forecast products to decision makers in selected sectors;

- Element 3: Institutionalizing Climate Forecasting Applications Networks

Demonstrate regional forecasting capacity, ensure long-term use of climate-forecast information and promote the establishment of a regional climate-forecasting network to interpret and apply new forecasting tools to decision making; and

- Element 4: Review and Evaluation

Review and evaluate both the process and progress at each step of the program, providing feedback for activities conducted under each primary element and supporting continued improvement in the application of climate forecasts.

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## Latin America and the Caribbean

As part of early Pilot Applications Program activities, beginning in 1992 NOAA-OGP and its partners throughout the region launched a series of workshops, training courses, and research and pilot applications projects in Central and South America and the Caribbean. These activities were intended to develop the understanding and multi-disciplinary networks essential to advancing the use of emerging forecasting capabilities, and for transforming scientific and technological developments into climate-information products that could be applied to reduce the social and economic disruptions associated with seasonal fluctuations in rainfall and temperature. In addition, these efforts were part of the global initiative to establish the IRI.

Gatherings of interested experts during the early 1990s were intended to serve as venues for the design of specific pilot projects that would enhance both the capacity of the region to capitalize on recent advances in the climate sciences, and to help the region identify and articulate research and information needs to ensure the most effective use and improvement of available knowledge. Workshops and training activities, some of which were conducted under the auspices of the IRI Pilot Training Project (see Background), were held in Argentina, Brazil, Costa Rica, Peru, and Uruguay from 1992 through 1996.<sup>10</sup> Participants in these events included researchers in both the physical and socioeconomic dimensions of climate, representatives of meteorological and hydrological services, and public- and private-sector decision makers and technical advisors.

Encouraged by these initial activities and the potential for forecast applications demonstrated by the experiences of Brazil and Peru during the late 1980s and early 1990s, NOAA-OGP established a partnership with the Inter-American Institute for Global Change Research (IAI), a regional research

entity, in order to advance initiatives of common interest related to climate research and forecast applications. The first official activity conducted via this partnership was a meeting on the “Application of Climate Forecasts in the Mesoamericas”, convened November 1996 in Arlington, Virginia. Focusing on the potential for sectoral uses of climate-forecast information, this meeting included participants skilled in climate research (both the physical and social sciences) and forecasting, and researchers/technicians from the agriculture, health, water management, and hydropower sectors.

The Arlington meeting recommended a series of 6-12 month preparatory studies in the Mesoamericas that would enhance understanding of the impacts of ENSO in the region, and that would also develop initial methodologies for acting upon climate-forecast information. Among the needs identified at the meeting was a mechanism to draw together information and researchers concerned with the impact of climate variability on human health, an emerging area of interest to governments, decision makers, and scientists alike. Toward this end, a workshop on “Climatic Changes and Human Health Linkages in the Tropical Americas” was convened May 1997 in Belize. Building upon earlier discussions, and specifically upon the recommendations developed by the Arlington and Belize workshops, a suite of pilot applications projects were established throughout the region and supported by a partnership of IAI and NOAA-OGP’s Pilot Applications Program for Latin America and the Caribbean (see list of applications projects).

Armed with predictions of the 1997-98 El Niño and based on relationships cultivated during the pilot applications projects, national, regional, and international agencies for the first time conducted formal and cooperative activities in response to the

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<sup>10</sup> “Workshop on ENSO and Seasonal-to-Interannual Climate Variability: Socio-Economic Impacts, Forecasting, and Applications to the Decision-Making Process,” September 1992 in Fortaleza and Florianopolis, Brazil. Followed by the Inter-American Institute for Global Change Research “Workshop on El-Niño Southern Oscillation and Interannual Climate Variability,” July 1994 in Lima, Peru; “Regional Workshop on Research and Applications of Climate Forecast in Decision Making in Southeastern South America,” September 1994 in Montevideo, Uruguay; “Symposium on Potential Uses of Seasonal-to-Interannual Climate Prediction in Water Resources Management in Central and South America,” July 1995 in Santa Fe, Argentina; and “Workshop on Seasonal to Interannual Climate Variability in Mesoamerica and the Caribbean and its Impact on Water Resources and Agriculture,” August 12-14, 1996, in San José, Costa Rica.

El Niño event. Among these responses were five Climate Outlook Fora in various parts of Latin America and the Caribbean as well as several national-level briefings to reach high-level decision makers and the media (see Table 1). These Outlook Fora and briefings were designed to produce, disseminate, and apply climate forecast technologies to real environmental, economic, and public security issues faced by the Latin American and Caribbean Regions (see section on Regional Climate Outlook Fora). Similar to other affected parts of the world, forecasts for the 1997-98 El Niño were utilized by individuals and institutions in Latin America and the Caribbean in efforts to reduce the negative impacts (or to benefit from) El Niño related changes in rainfall and temperature patterns. Forecasts were used particularly in sectors such as agriculture, environment, water resources, human health, fisheries, and natural disaster management.

Based on experiences accumulated from the pilot projects and interaction during the 1997-1998 El Niño, a group of institutions concerned with climate research, forecasts and impacts, and risk management are now proposing to the greater region a cooperative initiative to develop a Pan-American Climate Information System (PACIS). The PACIS will be an integrated set of activities that will advance the production, dissemination, and application of climate-forecast information in conjunction with scientific and technical training, and as a compliment to regional efforts focused on global change research. This initiative will tie together many previous activities undertaken by NOAA-OGP, the U.S. Agency for International Development Office of Foreign Disaster Assistance (USAID-OFDA), the World Meteorological Organization (WMO), IRI, IAI, and their regional partners (see also section on Regional Climate Outlook Fora-Recommendations).

# Latin America and Caribbean Pilot Applications Projects

PROJECT TITLE	INSTITUTION(S)	STATUS*
The Incorporation of ENSO Forecast Information into Reservoir Operation and Hydro-electric Power Distribution Procedures	University of Florida (UF)(Lead Institution, USA); Universidad Nacional de Colombia-Medellin (Colombia); Instituto Costarricense de Electricidad (Costa Rica); Instituto de Recursos Hidraulicos y Electrificación (Panama)	IP
An International Study on the Health Effects of ENSO in the Americas	Escola Nacional de Saúde Pública (Lead Institution, Brazil); Fundação Oswaldo Cruz; Johns Hopkins University (USA); Centro de Investigaciones Biometeorológicas-Consejo Nacional de Investigaciones Científicas y Técnicas (Argentina); Science Communication Studies (USA)	IP
Climate, Climate Forecasting, and Sugar Production in Trinidad and Tobago, West Indies	NOAA-Environmental Research Laboratories-Climate Diagnostics Center (NOAA-ERL-CDC)(Lead Institution, USA); NOAA-OGP; Cooperative Institute for Research in Environmental Sciences (CIRES); Caroni Limited (Trinidad and Tobago); Institute of Tropical Agriculture-University of the West Indies-St. Augustine (Trinidad and Tobago)	C
Applications of Multiple Lead-Time Climate Predictions in the Region of Central America and the Caribbean	University of Colorado (USA); NOAA-ERL-CDC (USA); Universidad de Costa Rica (UCR); Universidad Nacional Autónoma de México; University of the West Indies (Barbados); Caribbean Meteorological Institute (CMI); Meteorological Service of Belize	IP
A Study of Variations in the Spatial and Temporal Precipitation Patterns in the Trade Convergence Region	Centro del Agua del Trópico Húmedo para América Latina y el Caribe (CATHALAC)(Lead Institution); Universidad Santa María la Antigua (Panama); Universidad Tecnológica (Panama); UCR; Instituto Mexicano de Tecnología del Agua; Instituto de Meteorología (Cuba); Escuela Politécnica del Litoral (Ecuador); NOAA-Atlantic Oceanographic and Meteorological Laboratory (NOAA-ERL-AOML)(USA); Universidad de Panamá; Instituto Colombiano de Hidrología; Meteorología y Estudios Ambientales; Instituto Nacional de Recursos Naturales Renovables (Panama)	IP
Regional Assessments and Applications for Effects of Seasonal-to-Interannual Climate Variability and Application of ENSO-Based Climate Forecasts to Agriuculture in the Americas	University of Miami (USA); Florida State University (FSU)(USA); UF (USA); Instituto Nacional de Tecnología Agropecuaria (Argentina); Servicio Meteorológico Nacional (Argentina); Universidad de Buenos Aires (Argentina); Universidad de Belgrano (Argentina); Universidad de la República (Uruguay); Dirección Nacional de Meteorología (Uruguay); Instituto Nacional de Investigación Agropecuaria (Uruguay); International Fertilizer Development Center (IFDC)	IP
(Emerging) Initiative to develop a Pan-American Climate Information System (PACIS)	Institutions representing the research and forecasting dimensions of climate, as well as the sectors effected by climate variability, including natural disaster preparedness and risk management.	IP

\*STATUS: P= Planned; IP= In-Progress; C = Complete

## South Pacific

The tropical Pacific Island region is located in the heart of ENSO ocean warming, resulting in a high correlation between ENSO-related climate variability and impacts in this area. The South Pacific's direct experience with the effects of ENSO indicated a strong potential for regional applications of climate-forecast information. In recognition of this potential, NOAA-OGP organized and sponsored a meeting entitled "Workshop on Pacific ENSO Applications," held October 1992 in Honolulu, Hawaii. This meeting of natural and social scientists, federal and local government officials, and private-sector representatives provided impetus for developing forecast applications activities in the Pacific region.

The Pacific El Niño-Southern Oscillation (ENSO) Applications Center (PEAC) was established in 1994. Initiated with NOAA-OGP support, the PEAC is a cooperative pilot project between NOAA, the University of Hawaii, the University of Guam, and the Pacific Basin Development Council (PBDC). The PEAC was created to conduct research, produce information products, and perform outreach and education activities in response to ENSO-related climate variability in the U.S.-affiliated Pacific Islands (USAPI), including American Flag jurisdictions and Freely Associated States (former U.S. Trust Territories) of the tropical Pacific.<sup>11</sup>

In 1996, NOAA-OGP's Pilot Applications Program for the South Pacific began to broaden its focus beyond the USAPI. Building on PBDC experience and working closely with regional experts, NOAA-OGP in cooperation with the PEAC began to promote climate forecasting and applications in venues such as the South Pacific Forum, the South Pacific Commission, and the South Pacific Regional

Environment Programme. As a result of discussions at these regional conferences, NOAA-OGP sponsored and organized a meeting on "Applying El Niño-Southern Oscillation (ENSO) Related Climate Forecasts: Exploring Opportunities," July 1997 in Lami, Fiji. Participants from this meeting were to design an implementation plan for more comprehensive pilot forecast applications activities in the region.

The plan outlined activities and defined roles for NOAA-OGP, regional institutions, international organizations, key South Pacific countries, and others with interest in regional climate-forecast and applications activities. To meet the specific and varying needs of the Pacific Island region, applications activities included 6-12 month preparatory studies, site visits and training by climate and application experts, participation of outside experts in regional meetings of climate sensitive sectors, and distribution of regional climate-forecast information to the USAPI through the PEAC's "Pacific ENSO Update." Various projects outlined at the Fiji meeting evolved into fully-realized activities or were coordinated under the implementation plan (see list of applications projects), and to take advantage of broader global activities developing in connection with the IRI.

NOAA-OGP's Pilot Applications Program for the South Pacific directly participated in a number of activities during the 1997-98 El Niño that helped shape the region's response to the event, including a Pilot Activity Design Workshop (July 1997) and Pacific Science Association Inter-Congress (July 1997), and the South Pacific Regional Environment Program Conference on Climate Change in the Pacific (August 1997).

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<sup>11</sup> For a more complete description, see section on Related Activities-PEAC.

PROJECTTITLE	INSTITUTION(S)	STATUS*
Development of Regional Climate Newsletter with Forecast Information	South Pacific Regional Environment Programme (SPREP)	P
Phase two of Regional Climate Newsletter—Distribute Regional Climate Newsletter to User Communities	SPREP; Pacific ENSO Applications Center (PEAC)	P
Analyze Impact of ENSO Events on Sugar Cane Production in Fiji	Fiji Meteorological Service; Fiji Sugar Corporation; NOAA-CPC	P
Develop South Pacific Rainfall Atlas	Regional Meteorological Services; South Pacific Rainfall Climate Experiment (SPARCE); PEAC; NOAA-CPC	C
Economic Analysis of 1997-98 ENSO	SPREP with South Pacific Commission (SPC)	IP
Analysis of relationship between ENSO and Extreme Events	Intergovernmental Panel on Climate Change (IPCC); Climate Variability and Predictability Programme (CLIVAR); Australia Bureau of Meteorology (BMRC); NOAA-NCDC	IP
Country Workshops for Disaster Preparation	Meteorological Service Directors; Emergency Managers; Public Health Officials; United Nations Department for Humanitarian Affairs (UNDHA); World Meteorological Organization (WMO); World Health Organization (WHO); Tropical Cyclone Warning Center (EU); SPREP; PEAC; System for Analysis, Research, and Training (START); University of the South Pacific (USP)	P
Train Meteorologic Services and End Users in Climate Forecasting and Applications	SPREP; PEAC; IRI; START; NOAA-OGP	P
The Impact of ENSO on Water-Borne and Water-Related Diseases in the Tropical Pacific Islands	SPC; University of Hawaii; PEAC; NOAA-OGP	IP
Pilot Project to Analyze Relationship of Dengue and ENSO in the South Pacific and compare with Vietnam	University of Wellington; NOAA-OGP	IP
Develop Capability to Incorporate Climate Forecasts and Environmental Factors for Early Warning of Public Health Threats in the South Pacific	SPC; NOAA-OGP; Centers for Disease Control and Prevention (CDC)	IP
Assess Impacts of Environmental Variability on Tuna Fisheries in the Pacific Islands	Pacific Basin Development Council; University of Hawaii; NOAA-OGP	IP
Analyze Use of Climate Forecast Information in Guam Water Catchment Management	Water and Energy Resources Institute (WERI)	C

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## Southeast Asia

In the Southeast Asian region, NOAA-OGP first convened a “Workshop on Short-Term Climate Forecasts and their Applications for Social and Economic Benefit and Sustainable Development,” November 1994 in Bali, Indonesia. NOAA-OGP’s Pilot Applications Program for Southeast Asia began activities with a planning meeting in February 1997, again in Bali. Discussions during the planning meeting focused on the creation of a framework for the development of pilot forecasting and applications activities for the Asia-Pacific region, along with ways to extend regional development of this initiative.

Extremely dry El Niño conditions in Indonesia during 1997-98 set the stage for the burning of an estimated 5 million acres of forest (see Appendix). Not only were forest resources and habitat lost, but resultant smoke from these and forest fires in neighboring countries blanketed the region with haze. Haze pollution caused widespread, severe respiratory-health impacts, and limited visibility for air and seaborne transport. Building on the work of the February 1997 Workshop, the Pilot Applications Program for Asia had informally alerted the region in mid-1997 to impending dryer than normal conditions using computer-based predictions of the onset

of El Niño. After the fires had peaked, in November 1997 the Pilot Applications Program in cooperation with IRI participated in a comprehensive U.S. State Department response strategy assisting countries in Southeast Asia with the haze crisis. The goal of NOAA-OGP’s participation in this deployment was to highlight how longer-term thinking on the use of El Niño climate forecasts could help countries to set policies and better manage impacts, such as forest fire haze, during future climatic events.

Ongoing pilot applications activities coupled with the haze crisis helped catalyze the “Asian Regional Meeting on El Niño and Related Crises,” February 1998 in Bangkok, Thailand. This meeting was convened to discuss collective enhancement of capabilities for seasonal forecasting of El Niño-generated weather patterns and applications in countries of the region. Enhanced capability could provide for early warning and assessment of impacts, deliver information for contingency planning, and serve to educate the public. The first Climate Outlook Forum in Southeast Asia was also held during this meeting. The above objectives are supported through pilot applications activities in the region (see list of applications projects).



## Southeast Asia Pilot Applications Projects

PROJECT TITLE	INSTITUTION(S)	STATUS*
Training module on use of climate information for Asia disaster managers	Asian Disaster Preparedness Center (ADPC)	IP
Retrospective hindcasts of significant historical hydro-meteorological disasters	Various regional National Meteorological and Hydrological Services (NMHS); USAID-OFDA; IRI	IP
Inventory of regional climate and application institutions	Pacific ENSO Applications Center (PEAC); NOAA-OGP	P
Press kit and/or public information package	ADPC	IP
Farm level decisions in Northeast Thailand dryland rice farming	International Geosphere-Biosphere Programme/Global Change and Terrestrial Ecology Programme (IGBP/GCTE); System for Analysis, Research, and Training (START)	IP
Impact of climate variability on rice production in the Asia-Pacific region	International Rice Research Institute (IRRI)	C
International Rice Research Institute Simulation analysis of seasonal forecast influence on rice yield (field-scale) linking crop models with seasonal climate forecast models	IRRI	IP
Variability of precipitation in the Mekong River Basin in relation to the Southern Oscillation Index (SOI) and its utility for application	Mekong River Commission, Utsunomiya University	IP
Annual and seasonal-to-interannual variability in precipitation in the Australasian region (1978 - 1996)	Department of Natural Resources (DNR)-Queensland	C
Forecasting the risk of dengue fever epidemics in the Asia-Pacific region	University of Wellington; Vietnam Center for Environmental Research (CERED)	IP
Risk assessment of 1998-'99 mud slide vulnerability in Indonesia	ADPC; National Coordinating Board for Disaster Management (BAKORNAS)-Indonesia; NOAA-OGP; USAID-OFDA	IP

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## Africa

Building on relationships with regional investigators and institutions developed during the early 1990s, NOAA-OGP's Pilot Applications Program for Africa organized a small group of experts from key institutions in the U.S. and southern Africa to meet August 1995 in Washington, D.C., to develop a vision for social and economic applications of seasonal-to-interannual climate prediction in the region. Discussion focused on the creation of a framework for the development of pilot forecasting and applications activities for southern African over 1995-98, and on the organization of a workshop to be held in Victoria Falls, Zimbabwe, for launching extended regional development of this initiative. The goal of the August 1995 planning meeting, as a starting point from which the Victoria Falls Workshop could proceed, was to explore options for preparatory studies, and for discrete projects that would identify uses for climate information and highlight the needs of decision makers for this knowledge in different sectors. It was anticipated that the Victoria Falls meeting would also define the most effective predictive information products and delivery mechanisms for climate information, resulting in an enhanced regional expertise to interpret and apply seasonal climate forecasts.

The "Workshop on Reducing Climate Related Vulnerability in Southern Africa," held October 1996 in Victoria Falls, Zimbabwe, was designed to maximize the long-term social and economic benefit of climate forecasts in southern Africa. Based on the success of initial preparatory studies launched in August 1995, workshop participants recommended more focused pilot applications projects tailored to build on existing activities within the region and to broaden the systematic production and distribution of experimental climate forecast products. The ultimate objective was to arrive at a regional climate forecast applications network.

The Victoria Falls workshop brought together members of the broad community of scientists, practitioners, and decision makers who would be the principal producers and users of climate forecasts. Their task was to design a practical structure for the

application of climate information toward reducing uncertainties in policy decisions in southern Africa. Four priority areas were identified as components of network development:

- A series of pilot demonstration projects designed to establish a framework for responding to climate forecast information in the areas of agriculture and food security, water resource management, public health, and forestry;
- Improvements in communications and connectivity using email and the internet;
- Training programs, educational opportunities, and fellowship possibilities across national and sectoral boundaries; and
- A regional climate outlook forum charged with arriving at an assessment (ideally a consensus) of the state of the climate for the upcoming season.

The first meeting of the Southern Africa Regional Climate Outlook Forum (SARCOF) was held September 1997 in Harare, Zimbabwe. NOAA-OGP, in cooperation with USAID-OFDA, IRI, WMO, the European Network for Research in Global Change (ENRICH), the United Kingdom Meteorological Office (UKMO), formed a multidisciplinary, multi-agency steering committee with regional partners—including the Southern African Transport and Communications Commission (SATCC)—to initiate SARCOF, an assembly of regional and international climate forecasters and potential users. Combining their knowledge of climate conditions in southern Africa, these experts provided users with a consensus, probabilistic assessment of the upcoming rainy season, with an established means to review and update forecasts as the season progressed. The consensus Climate Outlook produced at this meeting presented one of the first opportunities for users on a regional scale to systematically employ—albeit experimentally—probabilistic forecasts of rainfall distributions. It was intended that users would apply forecasts in a bid to incrementally improve the accuracy and

outcome of resource management decisions made in anticipation of expected impacts.

NOAA-OGP's role in launching Regional Climate Outlook Fora in Africa was integrated with its Program in the Pilot Applications of Climate Forecasting for Africa. Many of the Pilot

Applications Projects fed into the Outlook Fora, while others grew out of the Fora and associated discussions (see list of pilot applications projects completed and underway during the 1997-98 El Niño).

## Africa Pilot Applications Projects

PROJECT TITLE	INSTITUTION(S)	STATUS*
Development and Evaluation of Methods and Models for the Application of Seasonal Rainfall Forecasts to Water Resources Management in the Winterton Irrigation District of South Africa	University of Natal	IP
Combining Risk Map Analysis and Climate Prediction: Effects of El Niño on Rural Households in Zimbabwe	Save the Children Fund; USAID-OFDA; IRI	C
Assessing Current and Potential Use of Climate Forecasts for Communal Farm Management in Zimbabwe	Columbia University (CU); University of Zimbabwe (UZ); Drought Monitoring Centre (DMC); Agritex; USAID-OFDA	IP
Using Seasonal Climate Forecasts in Farm Management: A Guide for Agricultural Extension Agents in Zimbabwe	CU; UZ; DMC; Agritex; Zimbabwe Department of Meteorological Services (ZDMS); Zimbabwe National Early Warning Unit; USAID-Famine Early Warning System (USAID-FEWS); USAID-OFDA	C
Training on Seasonal Forecast Interpretation for Agritex Extensionists	DMC; Agritex; ZDMS	IP
South Africa Malaria Forecasting Project (on-going phase)	National Malaria Research Council; University of Zululand; D. LeSueur	IP
Surveillance and Monitoring of Environmental and Health Consequences of the 1997/98 El Niño in Mozambique	CU, Harvard Medical School; IRI; Ministry of Agriculture; Mozambique Meteorological Service	IP
The Role of ENSO in Malaria Transmission in Kakamega, Kenya	Global Change and Terrestrial Ecology Programme (GCTE); Kenya Medical Research Institute; International Center for Insect Physiology and Ecology (ICIPE)	IP
Applications of Climate Forecasts to Health and Disease in Southern Africa	Liverpool School of Tropical Medicine (LSTM); European Network for Research in Global Change (ENRICH)	C
Improving Epidemic Preparedness for Malaria Control in Africa through Seasonal Forecasting and the Monitoring of Climate Variability	LSTM; World Meteorological Organization-Regional Office for Africa (WHO-AFRO) Southern African Malaria Control Initiative	IP
Analysis of Responses to SARCOF Questionnaire: Pilanesberg Participant Survey	U.K. Natural Resources Institute; ENRICH; NOAA-OGP	C
SARCOF and the User Community: A Survey of Responses and Reactions in the Agricultural Sectors of Namibia, Tanzania, and Zimbabwe	ENRICH; Norway-Centre for International Climate and Environmental Research (CICERO)	IP

\*STATUS: P= Planned; IP= In-Progress; C = Complete

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PROJECTTITLE	INSTITUTION(S)	STATUS*
The Sensitivity of Specific Agricultural Activities in Zambia and Tanzania to ENSO-Related Weather and Climate Anomalies	University of East Anglia; Commonwealth Development Corporation; ENRICH	C
Information and Drought Preparedness: Responses to Increased Risk of Drought in Southern Africa	SOS Sahel; ENRICH; United Kingdom-Department for International Development (UK-DFID)	C
Assessing the Economic Value of Forecast Information in Southern Africa	United Kingdom Meteorological Office (UKMO); IRI; ENRICH	C
Forecast Quality, Forecast Applications, and Forecast Value: Cases from Southern African Seasonal Forecasts	IRI; UKMO	IP

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## Climate and Human Health

NOAA-OGP began climate and health activities in 1994, concurrent with an increasing capacity to predict seasonal-to-interannual climate variability and an active interest in the application of new climate-forecasting technologies in the area of human health. The climate system influences ecological systems which in turn affect human, plant, and animal health. Linking research on these systems offered new potential for using predictive climate tools for advance warning of climate-related public health threats, such as infectious disease outbreaks. Numerous social, political, and economic factors affect the impact of climate variability on health, requiring a strongly multidisciplinary research approach in order to understand these linkages. The complex connections between climate and health, however, had been little studied in an integrated fashion.

Recognizing the absence of any coordinated climate variability and health efforts, NOAA-OGP activities evolved in an attempt to better understand the nature of the problem, identify key research questions, develop strong institutional partnerships, and determine OGP's most effective role. Toward this end, NOAA-OGP sponsored and participated early-on in various national and international meetings, conferences, and workshops, including U.S. government interagency fora, aimed at bringing together the climate and health research communities. NOAA-OGP also helped initiate or support various climate and health pilot-applications projects, including activities in Africa, Latin America, Asia, and the Pacific (see list of research projects).

In July 1997, NOAA-OGP's Pilot Applications Program began coordinating the "ENSO Experiment," undertaking for the first time a topically-focused rather than regionally-centered research activity in the face of an actual climate event. This project was an interdisciplinary research effort to study the human health impacts of the 1997-98 ENSO event, and explore the potential for applying forecast information in the public health arena. The impetus for the ENSO Experiment originated from participants at the colloquium on "Climate Variability and Human Health: An

Interdisciplinary Perspective," held June 1997 in Montego Bay, Jamaica, and sponsored by the American Academy of Microbiology. One of the primary recommendations of the meeting was to use the El Niño event already underway as a natural laboratory to assess the influence of ENSO-related changes in climate on infectious disease threats to human health. This recommendation laid the foundation for launching the ENSO Experiment.

The over-arching objective of the ENSO Experiment was to examine the relationship between climate variability and human health, and to explore the potential for using climate-forecast information to provide early warning of conditions posing a public health threat. This experiment had four primary goals:

- To assess the impact of the 1997-98 ENSO event on human health;
- To enhance the dialogue among the climate, ecology, and health research communities and end users of forecast information;
- To document the use of forecast information in the health arena during this ENSO event; and
- To identify additional research and monitoring needs and future research requirements.

Approximately 25 research activities under the umbrella of the ENSO Experiment address infectious diseases around the world including cholera, dengue, malaria, hanta virus, and diarrhea and other water-borne diseases (see list of research projects). Projects range from field epidemiology to historical analysis, from modelling to mapping. NOAA-OGP has worked to enhance cross-disciplinary dialogue and partnerships among domestic and international researchers in academia, governments, international institutions, and the private sector, including developing strong interagency ties within the U.S. federal government. Many of the projects build on existing research programs that were already underway. The breadth of partnerships and projects reflects the fundamental multi-disciplinary nature of the climate and health problem.

Based on results and recommendations from participants, the ENSO experiment will continue to assess the health impacts of El Niño that — given lags in emergence — may continue to appear beyond the end of the event, as well as to study impacts expected from the evolving La Niña. It is

anticipated that the ENSO Experiment will expand to encompass other modes of climate variability besides ENSO, such as affects from the North Atlantic Oscillation (NAO) and Pacific Decadal Oscillation (PDO), as well as health impacts other than infectious disease.

## ENSO Experiment Research Projects

PROJECT TITLE	INSTITUTION(S)	STATUS*
<b>Water-borne Disease</b>		
Influence of El Niño-Southern Oscillation (ENSO) on the Epidemiology and Ecology of <i>V. cholerae</i> in Bangladesh	University of Maryland-Center of Marine Biotechnology (UMD-CMB); International Center for Diarrheal Disease Research in Bangladesh (ICDDR); Centro de Investigacion Cientifica y Education Superior de Ensenada (CICESE)	IP
Influence of El Niño-Southern Oscillation (ENSO) on the Epidemiology and Ecology of <i>V. cholerae</i> in Peru	UMB-CMB; ICDDR; CICESE	IP
El Niño and Cryptosporidium in the Eastern United States	The Johns Hopkins University (JHU); University of South Florida (USF)	IP
Incidence of Water-borne and Water-related disease in Florida during Current El Niño and previous El Niño years	USF	IP
Marine Ecological Disturbances—North America Eastern Seaboard	Harvard Medical School-Center for Health and the Global Environment; NOAA-OGP	IP
The Relationship of ENSO and Water-borne and Water-Related Disease in the Tropical Pacific	University of Hawaii; Pacific ENSO Applications Center (PEAC); The South Pacific Commission (SPC); NOAA-OGP; NOAA-CPC	IP
Hospital Admission Rates due to Diarrheal Disease in Lima Peru during the 1997-98 ENSO Event	JHU	IP
Historical Analysis of Cholera Dynamics in the Bengal Presidency 1870-1940 in relation to ENSO and Rainfall	CMB; UMD; London School of Hygiene and Tropical Medicine; National Institutes of Health (NIH); NOAA-OGP	IP
<b>Vector-borne Disease</b>		
Relationship of ENSO to Seasonality and Peaks in Dengue—Global overview, selected sites	Centers for Disease Control and Prevention, United States (CDC)-Dengue Branch-Puerto Rico; NOAA-OGP	P
Incorporating ENSO and weather data into Dengue transmission model-Texas, Puerto Rico, Louisiana	Department of Agriculture-Center for Medical, Agricultural & Veterinary Entomology (USDA-CMAVE); JHU	IP
Exploring the correlations between El Niño and Dengue in Peru	USDA-CMAVE; Naval Medical Research and Development Command	P
The Influence of ENSO and the Spatial Distribution of Dengue in Peru	Naval Medical Research Institute (NMRI)	P
Forecasting the risk of dengue fever epidemics in the Asia-Pacific Region	University of Wellington (UW)-New Zealand; Center for Environment Research Education and Development (CERED)-Vietnam; NOAA-OGP	IP

\*STATUS: P= Planned; IP= In-Progress; C = Complete



PROJECT TITLE	INSTITUTION(S)	STATUS*
<i>Vector-borne Disease (cont.)</i>		
Forecasting the risk of dengue fever epidemics in the Southern Africa Malaria Forecasting Project	National Malaria Research Council; UW-New Zealand; CERED-Vietnam; NOAA-OGP	IP
Incorporating ENSO and weather variables to improve Dengue transmission model in Bangkok: the early warning potential	USDA-CMAVE; JHU-School of Hygiene and Public Health	IP
Will ENSO increase malaria in the East African Highlands?	Danish Bilharziasis Laboratory-Denmark; University of Durham-U.K.; NOAA-OGP	IP
ENSO and St. Louis and Western Equine Encephalitis—California	University of California-Davis (UCD)	IP
ENSO and St. Louis Encephalitis—Memphis, Tennessee	CDC	P
Remote Sensing the Patterns of Vector-borne Disease in El Niño and non-El Niño Years	NASA-Center for Health Applications of Aerospace Related Technologies (CHAART)	IP
Linkages between Arboviral Epidemics and the El Niño-Southern Oscillation (ENSO)	NOAA-OGP; CDC-Dengue Branch, Puerto Rico	IP
Climate Forecasting and Remote Sensing: Exploring the Potential for Predicting Rift Valley Fever in Eastern Africa	Geological Survey (USGS); Department of Interior (USDOJ); NOAA-OGP; CDC; Agency for International Development-Office of Foreign Disaster Assistance (USAID-OFDA); NASA-CHAART	IP
The Impact of ENSO on Malaria in Colombia and Venezuela	London School of Hygiene and Tropical Medicine	IP
The Influence of Local Climate Parameters on Dengue and Malaria in Indonesia	Department of Defense (USDOD); NOAA-OGP; Department of State (USDOS); USDA	P
Kakamega ENSO and Vector Borne Disease Project—malaria component	Kenya Medical Research Institute; NOAA-OGP	IP
<i>Rodent-borne Disease</i>		
Predicting Hantavirus Pulmonary Syndrome—Four Corners, United States	JHU-Department of Microbiology and the Center for Global and Environmental Change; Indian Health Service-U.S. Public Health Service; CDC-U.S. Public Health Service; University of New Mexico; Environmental Protection Agency (USEPA)	IP
<i>Other</i>		
The Influence of El Niño on Air Quality and Related Health impacts in Southeast Asia	CDC; NOAA-OGP; USDOS	P
Surveillance and Monitoring of Health Consequences of the 1997-98 ENSO in Mozambique	NASA; Harvard Medical School Center for Health and the Global Environment; NOAA-OGP	IP

## Concluding Note

In many cases, NOAA-OGP's Pilot Program for the Application of Climate Forecasts catalyzed regional activities and set the scene for further projects related to the creation and application of climate information. The spectrum of regional projects, the ties built with regional individuals and institutions over the years, and the lessons learned about applications of climate forecasts through researcher/user dialogue fed necessary ideas, methodologies, and experiences into a process that helped spawn the Climate Outlook Fora—to be described in greater detail in the following sections.